CLAIMS

1. A method for encoding pixels of digital or digitized images, i.e. images consisting of a set of image dots, named pixels in two-dimensional images and voxels in three-dimensional images, each of said pixels or voxels being represented by a set of values which correspond to a visual aspect of the pixel on a display screen or in a printed image, characterized in that the pixels or voxels (5, 14) of at least one portion of interest of the digital or digitized image or each pixel or voxel (5, 14) of the set of pixels or voxels which form the image is uniquely identified with a vector whose components are given by the data of the pixels or voxels to be encoded (5, 14) and by the data of at least one or at least some or of all of the pixels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) around the pixels to be encoded and arranged within a predetermined subset of pixels or voxels included in the whole set of pixels or voxels which form the image.

2. An encoding method as claimed in claim 1, characterized in that the components of the pixel or voxel (5, 14) identifying vector are determined by selecting, as pixels or voxels surrounding the pixel to be identified, all the pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) that are directly adjacent to said pixel or voxel to be encoded.

3. A method as claimed in claim 1 or 2, characterized in that the components of the identification vector of a pixel or voxel to be encoded (5, 14) also consist of at least one or at least some or at least all of the pixels or voxels surrounding the pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) that are directly adjacent to said pixel or voxel to be encoded (5, 14).

4. A method as claimed in one or more of the preceding claims, characterized in that the components of the identification vector, corresponding to the pixel or voxel to be encoded (5, 14) and to the surrounding pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) are arranged in such a manner as to correspond to the distance relation of said pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) with one another and with the pixel or voxel to be encoded (5, 14), with reference to a predetermined reading sequence of surrounding pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27), selected for forming said identification vector and the pixel of voxel to be encoded (5, 14).

5. A method as claimed in one or more of the preceding claims, characterized in that the components of the identification vector are arranged in such a

manner that the pixel or voxel to be encoded (5, 14) has a central position which corresponds to the one taken in the image pixel or voxel set, obviously as related to the pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27), surrounding the pixel or voxel to be encoded (5, 14) which have been selected for determining the identification vector components.

6. A method as claimed in one or more of the preceding claims, characterized in that it includes the step of encoding a sequence of digital or digitized images of a single subject and relating to a single frame of said subject, which sequence includes at least two images acquired with a time interval therebetween, which identification vector for a pixel or voxel (5) to be encoded, having the same position in the pixel matrix which forms said sequence images, is formed by the value of said pixel or voxel to be encoded (5) and by the surrounding pixels or voxels selected to form the components of said identification vector for each image that is part of said image sequence.

7. A method as claimed in claim 6, characterized in that the identification vector for a pixel or voxel to be encoded (5) within a sequence of digital or digitized images includes the values of said pixel or voxel to be encoded and of the pixels or voxels selected to form the components of said identification vector of all the images of said sequence, the values of the pixel or voxel (5) to be encoded and of the

pixels or voxels around it, selected to form the components of the identification vectors, being ordered with respect to the instant whereat the individual images of the sequence were acquired, in such a manner as to form subsets of identification vector components, referred to the same image of the image sequence or to the same acquisition instant.

8. A method as claimed in claim 7, wherein the subsets of identification vector components referred to the different images of an image sequence are successively ordered with reference to the instant whereat the corresponding image of the image sequence to be encoded was acquired.

9. A method of processing digital or digitized images, operating based on image pixel or voxel encoding as claimed in one or more of the preceding claims 1 to 8 and 35 to 39, and characterized in that it includes generation of a teaching database and teaching of the processing system, including the following steps:

- Encoding a predetermined number of digital or digitized images into pixel or voxel identifying vectors;

- uniquely associating each identification vector to the corresponding type of object or to the corresponding quality, as determined by traditional image analysis and actually reproduced by each pixel or voxel encoded by the corresponding identification vector, with reference to a list of predetermined different types or qualities.

- Generating a teaching database for a processing system, which database comprises the binomials formed by said identification vectors and by the associated type or quality of the object reproduced by the corresponding pixel or voxel;

- Actually teaching the processing system, by entering and loading the teaching database therein or by allowing the processing system to access the database;

A repeatable processing step for different images or image sequences with no need to repeat the teacning step, and comprising the following steps:

- Encoding the pixels or voxels of a not otherwise evaluated image by identification vectors associated to each pixel or voxel;

- Entering said image pixel or voxel identifying vectors in the processing system to obtain, at the output of said processing system and as a result of the processing, the type or quality of the object represented by each image pixel or voxel, with reference to the object types or qualities included in the teaching database.

10. An image processing method as claimed in claim 9, characterized in that the processing system consists of an algorithm for comparing the pixel identifying vectors of the teaching database with the pixel identifying vectors of the encoded images to be processed or of the sequence of encoded images to be processed.

11. A method as claimed in claim 9 or 10,

characterized in that the processing system consists of a discriminating algorithm, of the type known as LDA.

12. A method as claimed in claim 9 or 10, characterized in that the processing system consists of an algorithm known as a neural network.

13. A method as claimed in one or more of the preceding claims 9 to 12, characterized in that the pixels or voxels of the processed image wherefor an object type or quality has been recognized are displayed differentially from each other and from the image, e.g. thanks to a certain aspect, like a predetermined different color or the like for each object type or quality option.

14. A method as claimed in claim 13, characterized in that the pixels or voxels of the processed image wherefor an object type or quality has been recognized are displayed differentially from each other and from the image, e.g. thanks to a certain aspect, like a predetermined different color or the like for each object type or quality option, and over the original image.

15. A method as claimed in claim 14, characterized in that the original image is displayed in a monochromatic mode, particular in black and white or a gray scale.

16. A method as claimed in one or more of the preceding claims 9 to 15, characterized in that the results of image processing are stored in the teaching database for the processing system.

17. A method as claimed in claim 16, characterized

in that, before being stored in the teaching database, the image processing results are validated by a visual control and/or other analysis means.

18. A method as claimed in claim 16 or 17, characterized in that image processing results are stored in the form of identification vectors for the pixels or voxels of the processed image, associated to the object type or quality assigned thereto upon processing.

19. A method as claimed in one or more of the preceding claims 9 to 18, characterized in that it is a method for recognizing types of objects reproduced by image pixels or voxels.

20. A method as claimed in one or more of the preceding claims 1 to 19 and 35 to 39, characterized in that it is a method for processing digital or digitized diagnostic images, aimed at the recognition of at least one type of tissue or anatomic or physiologic object or one quality thereof.

21. A method as claimed in claim 20, characterized in that it is a diagnostic image processing method for recognizing and discriminating benign tumor tissues and malignant tumor tissues, as reproduced by the pixels or voxels of the diagnostic images, the teaching database being composed of identification vectors for image pixels or voxels that represent said malignant and benign tumor tissues, uniquely associated to the corresponding tissue type.

22. A method as claimed in claim 21, characterized in that it is a method for recognizing and

discriminating benign tumor tissues, malignant tumor tissues and normal tissues, as reproduced by the pixels or voxels of the diagnostic images, the teaching database being composed of identification vectors for image pixels or voxels that represent said malignant and benign tumor and normal tissues, which vectors are uniquely associated to the corresponding tissue type reproduced by the pixels or voxels encoded into said vectors.

23. A method as claimed in claim 22, characterized in that it is a method for recognizing and discriminating benign tumor tissues, malignant tumor tissues, normal tissues and muscular tissues as reproduced by the pixels or voxels of the diagnostic images to be processed, the teaching database being composed of identification vectors for image pixels or voxels that represent malignant and benign tumor tissues, normal and muscular tissues, which vectors are uniquely associated to the corresponding tissue type reproduced by the pixels or voxels encoded into said vectors.

24. A method as claimed in one or more of claims 21 to 23, characterized in that it is a method for recognizing and discriminating benign tumor tissues and/or malignant tumor tissues and/or normal tissues and/or muscular tissues and image background, as reproduced by the pixels or voxels of the diagnostic images to be processed, the teaching database being composed of identification vectors for image pixels or voxels that represent malignant and/or benign tumor

tissues, and/or normal and/or muscular tissues and image background, which vectors are uniquely associated to the corresponding tissue type or background reproduced by the pixels or voxels encoded into said vectors.

25. A method as claimed in claims 9 to 20, characterized in that it is a method for measuring contrast agent perfusion, wherein a sequence of ultrasound or Nuclear Magnetic Resonance images of a predetermined anatomic part of a patient are detected after injecting so-called contrast agents in said anatomic part, which method includes the following steps:

- Generating a teaching database for the expert processing system comprising identification vectors for pixels or voxels or image sequences obtained when contrast agents are present, whereto a quality or type o perfusion behavior is associated, among different typical perfusion types or qualities;

- Actually teaching the processing system, by entering or handling data of the teaching database;

- Acquiring a sequence of images of an anatomic part after injecting contrast agents therein, and encoding the pixels or voxels of the images of said sequence, acquired as claimed in the preceding claims 1 to 8, into identification vectors for the pixels of said image sequence;

- Processing by the identification vector processing algorithm, which associates, based in the teaching database, a perfusion behavior type or a

perfusion quality to each identification vector, hence to each pixel or voxel of the image sequence;

- Displaying the image sequence, and highlighting the pixels or voxels associated to the different perfusion behavior qualities or types by means for unique visual aspect characterization of said pixels or voxels.

26. An image processing method as claimed in one or more of the preceding claims 9 to 20, which includes an image pixel or voxel encoding method according to the encoding method as claimed in claims 1 to 8, characterized in that it is a method for recognizing and displaying parts of moving organs or physiological structures, particularly of the heart, wherein a sequence of ultrasound or radiographic or Nuclear Magnetic Resonance images of the heart or of any other organ or physiological structure is acquired, which method includes the following steps:

- generating a teaching database in which each identification vector for pixels or voxels of a plurality of image sequences of the heart or any other organ or physiological structure encoded with the method as claimed in one or more of claims 1 to 8, is assigned the type or quality of what is reproduced by the corresponding pixel or voxel;

- Actually teaching the processing system, by entering or handling data of the teaching database;

- Encoding, by using the method as claimed in one or more of claims 1 to 8, a sequence of images of the heart or any other organ or physiological structure for

further processing;

- Processing said encoded sequence of images so that the processing algorithm may assign, based on the teaching database, the type or quality reproduced by each pixel or voxel of the encoded image sequence

- displaying the result and visually highlighting the pixels of voxels corresponding to specific types or qualities by uniquely changing the aspect of these pixels of voxels according to each of the specific types or qualities.

27. A method as claimed in one or more of claims 9 to 20, in combination with an image encoding method as claimed in one or more of claims 1 to 8 and for recognizing image defects or aberrations, wherein the following steps are included:

- generating a teaching database by encoding image pixels or voxels into identification vectors as claimed in one or more of claims 1 to 8, and wherein each identification vector for the pixels or voxels of said images is assigned the type or quality which defines the presence or absence of the image defect or aberration depending on whether the corresponding pixel or voxel reproduces or has or not said aberration or said defect;

- Actually teaching the processing system, by entering or handling data of the teaching database;

- Encoding images, by using the method as claimed in one or more of claims 1 to 8 and 35 to 39;

- Processing said encoded images so that the processing algorithm may assign, based on the teaching

database, the type or quality which defines the presence or absence of an image defect or aberration for each pixel or voxel of the encoded images;

Displaying the result and visually highlighting, by aspect change arrangements, the pixel/s or voxel/s which have been assigned the type which defines the presence of aberrations or defects and possibly indicating the quality of the aberration or defect assigned to a pixel or voxel, as distinct from the one assigned to other pixels or voxels, by further aspect differentiation of the pixel/s or voxel/s, uniquely related to the different defect or aberration qualities.

28. A method as claimed in claim 27, characterized in that it further includes defect removal, according to the following steps:

- Adding to the teaching database pairs of encoded images, which have or do not have image defects or aberrations, by associating the identification vectors with the corresponding types defining the presence or absence of pixel aberration;

- Encoding the pixels or voxels of an image and processing the latter to assign the type that defines the absence of presence of aberrations or defects, and possibly the quality of said aberrations or defects to each pixel or voxel of the image;

- Correcting the aspect of the pixels of voxels which have been found to have defects or aberrations by assigning them the aspect of the defect- or aberration-free pixels or voxels of the image, which is coupled,

in the teaching database, to the corresponding image which has said aberrations or defects.

29. A method as claimed in claim 27 or 28, characterized in that the processed images are previously or subsequently processed for specific recognition of the object types represented by the pixels.

30. A method as claimed in one or more of claims 27 to 29, characterized in that the type of defect or aberration is a defocusing defect and/or an artifact and/or a wrong exposure and/or a defective development.

31. A method as claimed in one or more of the preceding claims 9 to 20, in combination with an image pixel or voxel encoding method as claimed in one or more of claims 1 to 8 and/or 35 to 39, characterized in that it is a method of overlaying digital or digitized images of the same subject, obtained by different imaging techniques, which includes the following steps:

- Encoding each of the images of the same subject, obtained with different imaging techniques, as claimed in one or more of claims 1 to 8 and/or 35 to 39 ;

- Processing each of the images of the same subject, obtained with different imaging techniques, for recognizing types of objects or qualities as claimed in one or more of claims 9 to 26;

- Combining the information provided by the pixels of the different images, which are assigned to the same type of object, into a single image.

32. A method as claimed in one or more of claims 27 to 31, characterized in that it is provided in

combination with a method as claimed in one or more of claims 9 to 26.

33. A method as claimed in one or more of the preceding claims, characterized in that the digitized image is an image whose pixel size corresponds to a high resolution, below human eye resolution, the pixel data which are processed for recognition as claimed in claims 9 to 32, being used to control all the pixels of a high resolution pixel unit group which has such a number of pixels that the aspect of all the pixels of each pixel unit group is identical to that of the high definition pixel associated thereto and the displayed or printed image of said pixel unit group may be viewed or detected at the human eye resolution or worse.

34. A method as claimed in claim 33, characterized in that the number of high definition pixels which form the pixel unit group is adjustable and allows to define different enlargement levels.

35 A method according to one or more of claims 1 to 8 characterised in that instead of considering an image formed by single pixels, for coding purposes a minimu image area of different size may be defined which is formed by a predefinite certain number of adiacent pixels, the value of the said minimum image area formed by the said certain number of adiacent pixels being calculated as a linear or non linear combination and/or as the value of one or more statistical functions of the of the brightness and or color values of the single pixels forming the said minimum image area.

36. A method according to claim 34, charaterised in that as a value of the minimu image area it is used the mean of the brightness values of the single pixels forming the minimum image area and/or the variance thereof and/or additionally the mean and or the variance value of the colour values of the single pixels.

37. A method according to claims 35 or 36, characterized in that also the time dependency of the values relating to brightness and/or color of the single pixels forming the minimu image area is added, the time dependency of the combinations and/or of the statisitical functions of the brightness and or color values of the single pixels being used.

38 A method according to one or more of the preceding claims 35 a 37, characterized in that there are defined minimum neighborhood image area zones of the minimum image area to be coded each of which minimum neighborhood image area zones may be formed by a single selected pixels in the neighborhood of the minimum inage area to be coded or as a certain number of said pixels in the neighborhood of the said minimum image area to be coded.

39. A method according to claim 38, characterized in that the minimu neighborhood image area ones of the minimum image area to be coded have a number of pixels for each zone which is identical or different form the nmner of pixels forming the minimum image area to be coded.

40 A method according to one or more of the

preceding claims 9 to 34, characterized in that the digitalized image is coded according to the coding method of one or more of claims 35 to 39.